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**December 20, 2001**

**Occupational Illness Due to Pesticide Drift From A Sprinkler Application of Metam-Sodium**

The California Department of Health Services (CDHS) investigated a report of the evacuation of an elementary school in Santa Barbara County due to odor from a sprinkler application of metam-sodium. Over a six-day period metam-sodium was used to fumigate two fields in preparation for planting carrots. The process involved pumping metam-sodium from a tank via a closed system into an irrigation system where it was mixed with water and pumped through sprinklers up into the air and onto the field. Subsequent to the application, the treated fields were irrigated with water to incorporate the metam-sodium into the soil to slow the rate of volatilization. When metam-sodium is diluted with water during the application process it breaks down chemically and releases methyl isothiocyanate (MITC).

## Findings and recommendations

- The use of metam-sodium in an overhead sprinkler system released MITC into the air which drifted off-site and resulted in at least three cases of pesticide poisoning among workers up to one mile from the application site. *CDHS recommends that growers implement low toxicity alternatives to the use of metam-sodium for pest control.*

- During sprinkler applications of metam-sodium, a residential buffer zone of less than one mile, maintained for 48 hours, does not provide workers with adequate protection from exposure to MITC. *CDHS recommends that a minimum one-mile worker buffer zone be required for all sprinkler applications of metam-sodium. The one-mile buffer zone should be maintained for at least 72 hours.*

- Odor detection as a field monitoring practice for metam-sodium is not health protective. *CDHS recommends that the current regulatory requirement that workers monitor applications of metam-sodium for odor be reassessed. Employers should ensure that workers performing field-monitoring use appropriate respiratory and eye protection at all times.*

## Background

The Sentinel Event Notification System of Occupational Risk (SENSOR) Pesticide Poisoning Prevention Project is conducted by the California Department of Health Services Occupational Health Branch (CDHS) through the support of the National Institute for Occupational Safety and Health and the US Environmental Protection Agency. The goal of the SENSOR project is to prevent pesticide poisoning among workers. SENSOR staff utilize a physician-based reporting system to conduct state-wide surveillance of pesticide illness among workers. Selected cases are followed up by a workplace investigation and interviews with workers, employers, and others involved in the incident. The investigations assess factors that may have contributed to occupational illness and make recommendations to prevent pesticide poisoning among workers.

On May 21, 1999, CDHS received a Pesticide Episode Transmittal Report from the California Department of Pesticide Regulation reporting an evacuation of an elementary school in Santa Barbara County due to odor from an application of metam-sodium. An Industrial Hygienist and a Bilingual Research Associate from the SENSOR project conducted an on-site investigation (June 16-17,1999) in the community where the incident occurred. SENSOR staff:

- interviewed the grower;
- interviewed eight workers: the three workers who applied the pesticide to the field next to the school, two of 26 school employees, one of four emergency responders, and two workers at an automotive repair shop near to the application site;
- gathered health symptom data for ten workers: for five workers by interview, for three workers by interview and medical records review, and for two workers by medical record review only; and
- observed and photographed the fields and community where the incident occurred.

## Incident

The incident occurred in Cuyama, California (Figure 1). Over a six-day period metam-sodium was used to fumigate two fields in preparation for planting carrots (Table 1). The same grower operated both fields, the same individual supervised all applications, and the same application process was used for all six days. Similar weather conditions existed on each day of the six-day period, and were characterized by variable ambient air temperature, wind speed and direction, and relative humidity throughout each 24 hour-period (Table 2). The prevailing wind direction was from the east or northeast, depending on the day.

The process involved pumping metam-sodium from a tank via a closed system into an irrigation system where it was mixed with water and pumped through sprinklers up into the air and onto the field (Figure 2).[1] Subsequent to the application, the treated fields were irrigated with water to incorporate the metam-sodium into the soil to slow the rate of volatilization (i.e., “water sealed”).

On day four of the application, the Fire Department and Sheriff responded to a complaint of an odor in the vicinity of an automotive repair shop. At the time the odor was detected, an application of metam-sodium was being made to Field #2, about a mile from the automotive repair shop (Figure 3). The Fire Department officials did not detect a strong odor and left the scene. Later that evening, the Sheriff‘s Department detected an odor that was traced to agricultural fields near the school.[2]

On the morning of day six, Fire Department officials received complaints of odor and reports of sick children at the Cuyama Elementary school which had an enrollment of 230 pre-school and elementary school-age children. The school is surrounded by Field #1 and is about a mile north of Field #2 (Figures 3 and 4). Paramedics from the Fire Department set up a medical screening area on the school premises. All children and workers were eligible for the voluntary evaluation. In response to reports of symptoms in children and information about the use of pesticides in the fields nearby the school, the Fire Department recommended the evacuation of the children from the school. At 1:10 PM, the students were evacuated from the elementary school and bused about three miles west, to Cuyama Valley High school. Classes for the elementary school children were held in the high school on Thursday. The school was closed on Friday, and classes resumed at the elementary school on Monday.

CDHS obtained symptom data for 10 workers through interview and/or medical records. Of the 10 workers, four detected odor and six reported one or more symptoms. The most common symptoms experienced were:

teary eyes, eye irritation, headache, nausea, cough, and upper respiratory pain or irritation (Table 3).

As indicated in the box below, when metam-sodium is diluted with water during the application process it breaks down chemically and releases methyl isothiocyanate (MITC), hydrogen sulfide gas, and other chemicals such as methylamine and carbon disulfide in smaller quantities.[3] When MITC degrades due to photolysis, the chemical methyl isocyanate is formed.[4,5] Trace levels of MITC were detected in all eight air-monitoring samples collected at the elementary school approximately 35 to 39 hours after the final application of metam-sodium.[6]

| metam-sodium | methyl isothiocyanate<br>hydrogen sulfide<br>methylamine<br>carbon disulfide | methyl isocyanate |
|---|---|---|

Based on self-reported evidence of exposure, the presence of two or more abnormal symptoms occurring after exposure, and the presence of symptoms and signs that are consistent with the known toxicology of exposure to MITC, CDHS found that the application of metam-sodium in this incident resulted in at least three cases of work-related pesticide poisoning among workers in a variety of occupational settings.[7]

**Figure 1. Cuyama is located in Santa Barbara County about 130 miles north of Los Angeles, and 315 miles south of San Francisco.**

## Table 1. Timeline of metam-sodium applications and events near Cuyama Elementary School, May 14-19, 1999

| Day | Date | Field #1 (75 acres treated) | Field #2 (100 acres treated) | Odor or symptoms reported* |
|---|---|---|---|---|
| 1 | Friday May 14 | 7-9 PM metam sodium applied to 25 acres with water seal ending at 6AM Saturday | | none |
| 2 | Saturday May 15 | 7-9 PM metam sodium applied to 25 acres with water seal ending at 6am Sunday<br><br>second water seal applied to 25 acres treated Friday | | none |
| 3 | Sunday May 16 | 11 AM – 1 PM metam sodium applied to 25 acres with water seal ending at 9 pm<br><br>second water seal to 25 acres treated Saturday | | PM –individual on school grounds experienced headache and burning eyes - no medical attention sought |
| 4 | Monday May 17 | water seal to all 75 acres treated | | 6:30 AM - rotten egg smell detected at school, nausea experienced - no medical attention sought |
| | | | 7-10 PM metam sodium applied with water seal ending at 4 am | 8:30 PM strong odor from south east detected at automotive garage located about one mile from Field 2 – medical attention sought next day |
| 5 | Tuesday May 18 | water seal to all 75 acres treated | 4 – 8 AM metam sodium applied with water seal ending at 2 pm;** second water seal beginning at 6 pm<br><br>second water seal to section treated on Monday | PM - headache and burning eyes experienced by individual on school grounds – no medical attention sought |
| 6 | Wednesday May 19 | water seal to all 75 acres treated | 12 midnight – 3 AM metam sodium applied with water seal ending at 9 AM; second seal applied around 3 PM | AM symptoms reported at school - medical attention sought |

* Based on Agricultural Commissioner Pesticide Episode Investigation Report. Episode No: 25-SB-99 and CDHS interviews; ** Metam-sodium injection line broken – about 5 gallons reportedly spilled on soil surface; the applicator reportedly scooped up the contaminated soil and put it in the treated area to be watered in.

**Table 2. Weather data over the six-day pesticide application process**

| Day | Air Temp. (min-max) ($^0$F) | Wind Direction *Range* (0-360 degrees) | Wind Direction *Prevailing* | Wind Speed *Range* (mph) | Wind Speed *Average* (mph) | % Relative humidity (min-max) |
|---|---|---|---|---|---|---|
| 1 | 36 – 74 | 52.82 - 355.20 | E | 2-10 | 5 | 12.3 – 93.9 |
| 2 | 33 – 62 | 11.51 - 255.40 | NE | 1-7 | 4 | 30.8 – 99.3 |
| 3 | 36 – 68 | 35.77 - 285.50 | NE | 2-8 | 5 | 26.3 – 98.7 |
| 4 | 38 – 76 | 60.87 - 231.70 | E | 2-9 | 5 | 24.4 –80.8 |
| 5 | 43 – 77 | 34.90 - 272.90 | NE | 2-8 | 5 | 24.4 – 79.6 |
| 6 | 40 - 74 | 52.52 - 307.70 | E | 1-8 | 5 | 35.9 – 98.2 |

*Source: CIMIS Project Weather Data for Station #88 Cuyama*

**Table 3. Symptoms and signs of pesticide intoxication among 10 workers in Cuyama**

| Symptom/Sign | No.* | Symptom/Sign | No.* |
|---|---|---|---|
| **SYMPTOMS** | | **Skin** | **1** |
| **Respiratory** | **4** | Irritation | 1 |
| Cough | 3 | | |
| Upper Respiratory pain/irritation | 3 | **Eye** | **4** |
| Shortness of breath | 1 | Irritation | 3 |
| Wheezing | 1 | Tearing | 4 |
| | | Pruritis | 2 |
| **Gastrointestinal** | **3** | | |
| Nausea | 3 | | |
| Abdominal pain or cramping | 1 | | |
| | | **SIGNS** | |
| **Nervous System** | **4** | **Cardiovascular** | **1** |
| Ataxia | 1 | Hypertension | 1 |
| Irritability | 1 | | |
| Dizziness | 1 | | |
| Headache | 3 | | |

**Figure 2. The application involved pumping metam-sodium onto the field using a sprinkler irrigation system (indicated by arrow)**

**Figure 3. Proximity of school and garage to pesticide-treated fields**

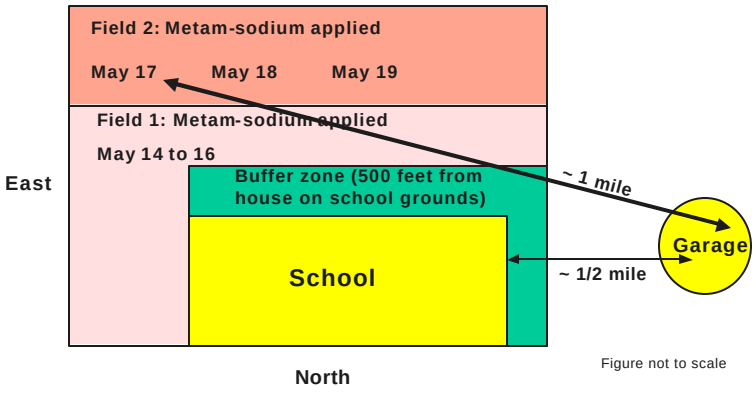



**Figure 4. Fence separating Cuyama Elementary School, on the right side, from the metam-sodium treated field on the left**

## Discussion

Pesticide drift refers to the movement of pesticides away from the site of application.[8] This incident illustrates that during the application of metam-sodium through an overhead sprinkler irrigation system, MITC can drift off-site and result in pesticide illness among exposed individuals. The workers who became ill in this incident were exposed to pesticides while working in non-agricultural occupations. It is not uncommon for pesticide drift to cause illness among workers in non-agricultural occupations and industries. For example, in 1998-99, exposure to pesticide drift in California resulted in illness among teachers, construction workers, bus drivers, meter readers, laborers, and janitors.[9] Between 1991 and 1998, 961 (60.1%) of the 1,599 reported cases of acute work-related illness caused by pesticide drift in California occurred among employees of non-agricultural firms.[10]

The onset of odor and irritant symptoms associated with MITC exposure would be expected shortly after the exposure begins, and ambient levels of MITC would be expected to decline over time.[3,11] The detection of odor and onset of symptoms in this incident most closely coincides with the applications to Field #2 on days four and six (Table 1). Therefore, CDHS concludes that the application of metam-sodium to Field #2 probably caused the illnesses of the workers about one mile away in the vicinity of the automotive repair shop on Monday evening, and at the school on Wednesday morning. The application to Field #1 may have also caused illness among workers off-site because symptoms consistent with MITC exposure were also experienced prior to the application to Field #2 (Table 1).

CDHS' findings are likely to have underestimated the extent of illness caused by the applications of metam-sodium in Cuyama (May 14-19, 1999) for the following reasons:

- At least 27 workers who were potentially exposed were not interviewed by CDHS; [12]

- Non-occupational exposures such as those potentially incurred by school children and other community members were excluded from CDHS' work-related investigation. The investigation by the Santa Barbara County Agricultural Commissioner indicates that community members may have also experienced health impacts due to the metam-sodium application to one or both of the treated fields;[2]

- Cuyama is located about 40 miles from the nearest health care provider. This distance may have discouraged symptomatic individuals from seeking medical care;

- Exposed individuals may not have recognized they were being exposed to the pesticide, or, that their symptoms were related to pesticide illness;

- Health care providers may not have attributed any reported symptoms to pesticides without specific application information.

## Factors that contributed to these pesticide-related illnesses include:

(1) the toxicity of metam-sodium;

(2) an inadequate physical and temporal buffer zone between workers and the application; and

(3) undue reliance on the detection of odor as a warning of acute health hazards.

## 1. Toxicity of metam-sodium

In California, between 1992 and 1999, the California Department of Pesticide Regulation (CDPR) documented 259 cases of illness attributable to drift exposure to metam-sodium alone or in combination with other chemicals.[13] When metam-sodium is used as a soil fumigant, MITC is released into the air. It is well established that MITC is highly toxic.[14] Exposure to MITC vapors can cause severe irritation of the eyes and respiratory tract, headache, dizziness, nausea, and diarrhea.[15, 16] Inhalation of MITC can cause long-lasting effects, such as reactive airways dysfunction syndrome or "RADS".[17] Various airborne contaminants are more likely to cause respiratory irritation in individuals with RADS than in normal individuals.[18] Once RADS develops there may be long-term sequelae and chronic airways disease.[19] Workers exposed to MITC on the job may also incur skin exposure, which can cause an irritant dermatitis and/or sensitization. [20, 21, 22]

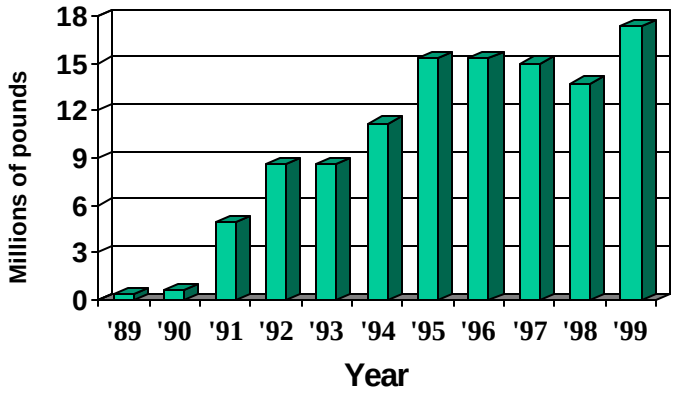
The other chemicals released in lesser quantities when metam-sodium is mixed with water are also highly toxic. Hydrogen sulfide is a respiratory depressant. Acute inhalation may cause headache and dizziness in addition to irritation of the eyes and mucous membranes.[23, 24] Methyl isocyanate is extremely irritating and acute inhalation exposure may result in damage to multiple organ systems, including the eye, respiratory tract

gastrointestinal tract, and the liver and kidney.[25] Simultaneous inhalation exposure to MITC, hydrogen sulfide, and methyl isocyanate may occur. The effects of a combined exposure to all three chemicals are not known. However, because all three chemicals can harm the lungs and eyes, it is plausible that inhaling a combination of all three chemicals may result in additive or synergistic effects.[26]

Individuals exposed to metam-sodium are at risk of long-term health impacts. Metam-sodium is listed on California's Proposition 65 list of chemicals known to cause reproductive (developmental) toxicity, and it is also on California's Proposition 65 list of chemicals known to cause cancer.[27]

The accepted strategy for controlling toxic airborne contaminants is to first attempt to eliminate the generation source.[28] For example, consistent with this approach, the California Medical Association has called for a reduction in the use of pesticides with significant acute and chronic toxicity that have the capacity to drift to schools and residential areas.[29] In contrast to this approach, the use of metam-sodium has increased over the past decade (Figure 5).

**Figure 5. Pounds of metam-sodium applied in California by year**




*Source: California Department of Pesticide Regulation, Summary of Pesticide Use Reporting by Year http://www.cdpr.ca.gov/docs/pur/purmain.htm*

The use of metam-sodium and the highly toxic fumigant methyl bromide increased in part as a response to regulatory measures that prohibited the use of 1,3-dichloropropene after Air Resources Board Monitoring stations detected levels of public health concern in ambient air. [30,31,32] Currently, methyl bromide is being phased out because the use of this pesticide depletes the ozone layer. This has further led to increased usage of

metam-sodium, which is recognized as the most efficacious registered chemical alternative to methyl bromide against weeds.[33]

Increased usage of metam-sodium because of the limitations and restrictions placed on both 1,3- dichloropropene and methyl bromide illustrates that in addressing public health problems, the substitution of one toxic chemical with other chemicals may result in illness if the toxicities are not taken into account. The elimination of the use of toxic substances and the substitution of alternative methods is a primary goal of sustainable agriculture.[34] Consistent with this approach, CDPR has identified several technically feasible non-chemical alternatives to the use of methyl bromide.[33]

**CDHS concludes that the use of metam-sodium in an overhead sprinkler system released MITC into the air which drifted off-site and resulted in at least three cases of pesticide poisoning among workers up to one mile from the application site. Growers should implement low toxicity alternatives to the use of metam-sodium for pest control.**

## 2. Inadequate physical and temporal buffer zone

In California, to minimize drift when applying metam-sodium, applicators are required to adhere to buffer zones as well as other requirements established in the Technical Information Bulletin (TIB) and the Department of Pesticide Regulation's Permit Conditions.[35,36] A "buffer zone" is an area that surrounds a pesticide application block in which certain activities are restricted for a specified period of time to protect human health and safety from existing or potential adverse effects associated with a pesticide application.[37]

Overhead sprinkler applications of metam-sodium are prohibited within 500 feet of "sensitive sites" such as schools, churches and day care centers.[36] Agricultural Commissioners may increase the size of the buffer zone based on their evaluation of the site. The buffer zone requirements are also extended to up to one-half mile if ambient air temperature, irrigation system pressure, and water seal requirements cannot be met.[35] Agricultural Commissioners specify the time period during which the buffer zone must be maintained based on their evaluation of the site. For the application of metam-sodium in this incident, the buffer zone of 500 feet was required to be maintained for 48 hours after the application was completed.[38]

In this incident, exposure to MITC caused illness in workers up to one mile from the metam-sodium application site. Similar incidents of illness due to drift from metam-sodium applications have been reported. For example, in 1996, 11 cases of pesticide-related illness were documented among

workers in San Joaquin County located approximately 0.8 mile from a sprinkler application of metam-sodium.[39]

Air monitoring data reported by the CDPR indicate the potential for individuals located at a distance of 500 feet from a metam-sodium application site to be exposed to MITC at levels of health concern. MITC levels in air samples obtained approximately 500 feet from a sprinkler application of metam-sodium ranged from 1320 parts per billion (ppb) during the application, decreased to 8.06 ppb 37.5 hours after the application, and then decreased to less than 2 ppb (the limits of detection) 49.5 hours after the application.[40] For comparison, the California Environmental Protection Agency's Office of Environmental Health Hazard Assessment has estimated the one hour MITC exposure levels to prevent discomfort, disability, and life-threatening injury among a diverse human population to be 0.5 ppb, 40 ppb, and 150 ppb, respectively.[3]

Together, the findings of this incident, other illness reports, and limited air-monitoring data, indicate that the current buffer zone restrictions for metam-sodium applied in the overhead sprinkler system are not adequate to prevent acute pesticide illness. Moreover, just as individuals who reside in the buffer zone, individuals working in the buffer zone are susceptible to health impacts from exposure to MITC. This is because: (1) all individuals exposed to MITC for a short time may experience serious respiratory and eye irritant health effects; and (2) workers may live near the application site and have additional acute and chronic exposures in their community. Therefore all workers, including individuals involved in agricultural and non-agricultural activities, should be included in the buffer zone restrictions.

The TIB prohibits the application of metam-sodium during windy conditions (>7 mph). Wind data reported by CDPR during a sprinkler application of metam-sodium in 1994 illustrate that wind can change direction and speed during and after an application.[40] The CDPR data showed that during the six-hour period when the metam-sodium was applied wind speeds ranged from one to10 miles per hour; over the 67.5-hour period after the application wind speeds ranged from zero to 11 miles per hour; wind speeds of seven miles per hour or more were recorded during the application, water sealing and post-application periods (Figure 6). CDPR monitoring data showed prevailing wind direction also varied during and after the application. It is notable that MITC was measured in both "downwind" and "upwind" monitoring sites, indicating that wind direction may be considered a relative, but not absolute, indicator of exposure to pesticide drift.

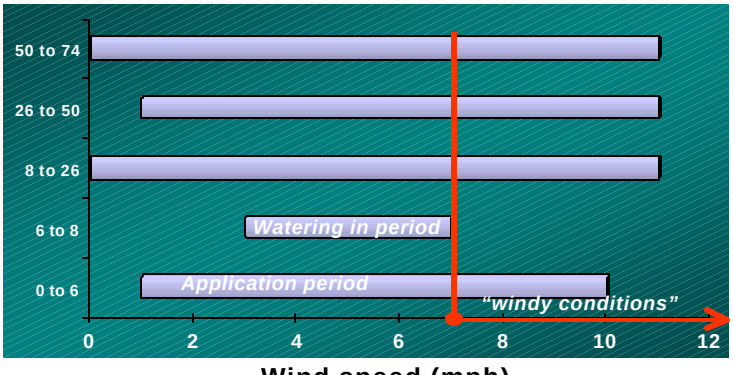
Hourly wind data obtained in Cuyama at the time of the application of metam-sodium in the 1999 incident that is the subject of this investigation also reflect that wind speed and direction varied during and after each application (Table 1).[41] Figures 7a and 7b indicate that for each of the six

applications of metam-sodium, the wind varied from approximately two up to at least eight miles per hour in the 24-hour period beginning with the application. For each of the six applications, wind speeds of eight miles per hour or more were recorded throughout the application, water sealing and/or post-application period.

In addition to wind speed and direction, the time it takes for metam-sodium to break down to MITC and be released into the air and dispersed into the surrounding community is governed by ambient temperature, soil type, temperature, and moisture content, and other factors (Table 4).[42, 43, 44] The TIB and Permit prohibit pesticide applications during thermal inversions, and hot and windy conditions. However, because environmental factors are numerous, complex, and subject to unpredictable variation over time, wind and temperature are not reliable exposure control measures. As indicated in Figures 6, 7a, 7b, and Table 4, stable wind conditions are not assured over long periods, and many factors, in addition to wind and temperature, will influence the dispersion of MITC into the surrounding community. Therefore, the time it takes for MITC levels to fall below levels of concern will vary. To prevent illness, all unprotected workers must be excluded from buffer zones for a sufficient period of time to account for this variability.

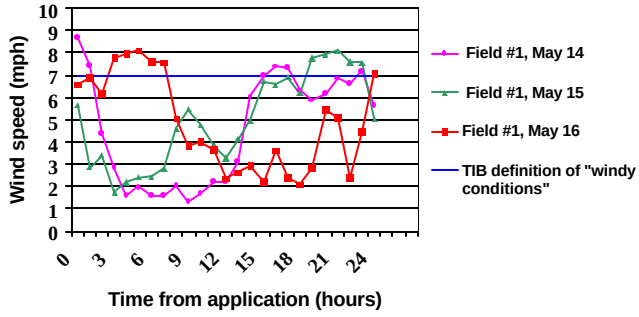
**CDHS concludes that during sprinkler applications of metam-sodium, a residential buffer zone of less than one mile, maintained for 48 hours, does not provide workers with adequate protection from exposure to MITC.[45] CDHS recommends that a minimum one-mile worker buffer zone should be required for all sprinkler applications of metam-sodium. The one-mile buffer zone should be maintained for at least 72 hours; CDHS notes that although a one-mile/72 hour buffer zone is expected to *increase* protection for potentially exposed individuals, it may not be 100% effective.**

**Figure 6. Range of wind speed during a 1994 sprinkler application of metam-sodium during application, watering in, and post-application time periods**



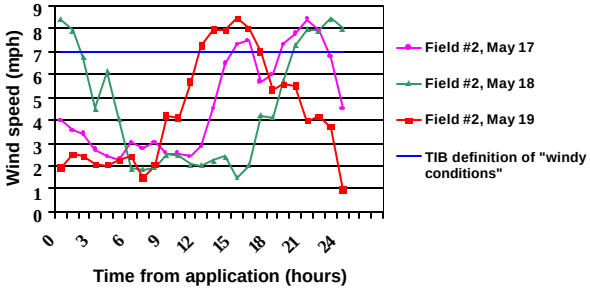

Source: California Department of Pesticide Regulation.
*Air monitoring for methyl isothiocyanate during a sprinkler application of metam-sodium. June 1994*

**Figure 7a. Variability of wind speed during sprinkler applications of metam-sodium in Field 1 Cuyama 1999**




Source: CIMIS Project: Hourly weather data for station # 88 Cuyama Sensor No: 8
May 14-19, 1999

**Figure 7b. Variability of wind speed during sprinkler applications of metam-sodium in Field 2 Cuyama 1999**




Source: CIMIS Project: Hourly weather data for station # 88 Cuyama Sensor No: 8
May 14-19, 1999

**Table 4. Factors that influence the breakdown and dispersion of metam-sodium into the surrounding community during a sprinkler application**

| | |
|---|---|
| Soil moisture | Ambient temperature |
| Soil temperature | Thermal inversions |
| Soil type and particle size | Number of acres treated |
| Soil pH | Application rate |
| Wind speed | Water pressure |
| Wind direction | Nozzle size |
| Prior treatment of field with metam-sodium | Irrigation rate |

## 3. Undue reliance on the detection of odor as a warning of acute health hazards

In addition to buffer zones, the metam-sodium TIB and Permit Conditions require that subsequent to the application, workers must go to the field and observe the field for odor every two hours for at least 12 hours. Permit conditions for metam-sodium also specify field monitoring be conducted on an hourly basis when the pesticide is applied within 1500 feet of an occupied structure.[36] The pesticide label states that pesticide handlers who monitor the field after an application of metam-sodium are required to wear respiratory and eye protection only if, "a pungent, rotten egg odor of [this] product can be detected outdoors". However, it is inappropriate to rely on the detection of odor as a warning of acute health hazards from MITC because:

- individuals vary in their ability to detect odors due to age, sex, previous exposure to the odor, health status, smoking, and genetics;[46, 47, 48, 49, 50,51, 52]

- workers may experience irritant symptoms of exposure prior to detecting an odor and may be unable to take preventive action. Specifically, the odor threshold of MITC (the level at which it is first detectable) ranges from 200 to 8,000 ppb.[53, 54] Estimated one-hour MITC exposure levels to prevent acute respiratory and eye irritation symptoms (22 ppb and 0.5 ppb) are nine to 400 times *less* than the lowest odor threshold (200 ppb).[55] This means that an individual may be unable to detect the odor of MITC when it is present in air at levels that may cause serious eye and respiratory effects. As previously noted, hydrogen sulfide is also produced when metam-sodium is mixed with water. However, although hydrogen sulfide has a very low odor threshold, it is known that this chemical, even after a short exposure, quickly becomes undetectable, making the smell of rotten eggs an unreliable indicator of the presence of hydrogen sulfide;[24,56]

- pesticide exposures occur under uncontrolled environmental conditions that can dramatically alter exposure potential.[57] Because the levels of MITC present will be influenced by unpredictable environmental conditions, workers may encounter unexpectedly high exposure levels;

- levels of MITC sufficient to produce adverse health effects are present near treated fields, and persons without appropriate protection would be expected to exhibit such effects;[58]

- workers may be unable or unwilling to leave the area even if they detect an odor or experience symptoms;

- workers may not recognize that they are being exposed to MITC, and that their signs and symptoms of illness are related to pesticide exposure.

CDHS concludes that the odor of MITC is not a reliable warning of an acute health hazard. Therefore, the current TIB, Permit and label requirements to monitor the field for odor, and to use eye and respiratory protection only if odor is detected, may result in workers being exposed to MITC at levels of health concern. Moreover, because the odor of MITC is an unreliable warning of acute health impacts, and workers who perform field monitoring will not all have the same or sufficient ability to detect odor, community members, as a result, are also afforded only limited protection by the current field-monitoring requirement. To prevent pesticide illness, exposure control measures should perform consistently and protect all potentially exposed populations**.**

**CDHS concludes that odor detection as a field monitoring practice for metam-sodium is not health protective. CDHS recommends that the current regulatory requirement that workers monitor applications of metam-sodium for odor be reassessed. Employers should ensure that workers performing field monitoring use appropriate respiratory and eye protection at all times.**

## Summary of findings and recommendations to prevent pesticide poisoning:

1. The use of metam-sodium in an overhead sprinkler system released MITC into the air which drifted off-site and resulted in at least three cases of pesticide poisoning among workers up to one mile from the application site.

   ***CDHS recommends that growers implement low toxicity alternatives to the use of metam-sodium for pest control.***

2. During sprinkler applications of metam-sodium, a residential buffer zone of less than one mile, maintained for 48 hours, does not provide workers with adequate protection from exposure to MITC.

   ***CDHS recommends that a minimum one-mile worker buffer zone be required for all sprinkler applications of metam-sodium. The one-mile buffer zone should be maintained for at least 72 hours.***

3. Odor detection as a field monitoring practice for metam-sodium is not health protective.

   ***CDHS recommends that the current regulatory requirement that workers monitor applications of metam-sodium for odor be reassessed. Employers should ensure that workers performing field-monitoring use appropriate respiratory and eye protection at all times.***

## References

[1] The grower did not keep metam-sodium application or monitoring records as required by the Technical Information Bulletin, and did not submit Pesticide Use reports to the Agricultural Commissioner as required by the CCR 6626 (a). Therefore, it was not possible to verify the application information. The grower reported to CDHS that Field #1 was treated with 50 gallons of the pesticide product per acre, which is equalvalent to applying 213 pounds of metam-sodium per acre. (Calculation: [4.26 pounds of metam-sodium per gallon of pesticide product] X [50 gallons applied per acre] = 213 pounds of metam-sodium per acre X 75 acres treated = 15,975 pounds of metam sodium were applied to Field #1.)

[2] Agricultural Commissioner Pesticide Episode Investigation Report. Episode No: 25-SB-99.

[3] Alexeeff GV, Shusterman DJ, Howd RA, Jackson RJ. *Dose-response assessment of airborne methyl isothiocyanate (MITC) following a metam sodium spill*. Risk Analysis, Vol. 14 (2):191-198 (1994).

[4] Department of Pesticide Regulation. Permit Conditions for Applications of Metam-Sodium and Potassium N-methydithiocarbamate (Metam-Potassium) Products. Enforcement letter 2000-044, November 15, 2000.

[5] Geddes JD, Miller GC, Taylor GE. Gas phase photolysis of methylisothiocyanate. American Chemical Society. Abstracts of papers 208th ACS National Meeting, August 21-25, 1994.

[6] Eight air-monitoring samples were collected as part of the Santa Barbara County Agricultural Commissioner's investigation on Thursday, May 20, 1999 between 2:18 PM and 5:51 PM. Six samples were obtained in school classrooms, one sample was obtained at the school playground, and one sample at the east end of Washington Street, approximately 300 yards from the school. All eight air-monitoring samples had MITC at levels less than 0.01 milligrams per cubic meter of air.

[7] Council of State and Territorial Epidemiologists. Inclusion of acute pesticide-related illness and injury indicators in the National Public Health Surveillance System (NPHSS). Atlanta, GA: The Council; 1999. Available from: URL: http://www.cste.org/ps1999/ENV3.doc . Accessed September 14, 2000. In addition to the three cases classified as pesticide-related illness, the fourth case was classified as suspicious. There was insufficient information to classify the symptoms reported by the fifth and sixth workers as pesticide-related.

[8] Marer PJ, Flint ML, Stimmann MW. The safe and effective use of pesticides. University of California, Statewide Integrated Pest Management Project, Division of Agriculture and Natural Resources Publication 3324. 1988 page 227.

[9] California Department of Health Services SENSOR project, unpublished data, 2001.

[10] California Department of Pesticide Regulation, unpublished data, 2001.

[11] Wofford PL, Bennett KP, Hernandez J, Lee P. Air Monitoring for Methyl Isothiocyanate During A Sprinkler Application of Metam-Sodium. Cal/EPA, Department of Pesticide Regulation, Environmental Hazards Assessment Program and California Department of Food and Agriculture, Chemistry Laboratory Services. June 1994. See Figure 3, "MITC dissipation from field after chemigation of metam-sodium", page 15.

[12] This includes three emergency responders and 24 school employees.

[13] California Department of Pesticide Regulation. Personal communication with Louise Mehler, MD, Worker Health and Safety Branch. Data generated April 19, 2001.

[14] The US EPA ranks pesticides into four acute toxicity categories. The most acutely toxic pesticides are in category I (highly toxic, signal word DANGER). MITC is designated as acute toxicity category l pesticide.

[15] Nihon Schering KK and Shionogi and Co., Ltd. Summary of toxicity data on methyl isocyanate (MITC). J. Pesticide Sci. 15:297-304 (1990).

[16] Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. Evaluation of the Health Risks Associated with the Metam Spill in the Upper Sacramento River. September 21, 1992. page 10.

[17] Cone JE, Wugofski L, Balmes JR, Das R, Bowler R, Alexeeff G, Shusterman D. *Persistent respiratory health effects after a metam-sodium pesticide spill*. Chest 1994; 106:500-508.

[18] Boulet LP. *Increases in airway responsiveness following acute exposure to respiratory irritants. Reactive airway dysfunction syndrome or occupational asthma?* Chest 1994; 94(3): 476-481.

[19] Brooks SM, Weiss MA, Bernstein IL. *Reactive airways dysfunction syndrome (RADS). Persistent asthma syndrome after high level irritant exposures*. CHEST Vol. 86 (3):376-384 September 1985.

[20] Koo D, Goldman L, Baron R. *Irritant dermatitis among workers cleaning up a pesticide spill: California 1991*. American Journal of Industrial Medicine 27:545-553 (1995).

[21] Richter G. *Allergic contact dermatitis from methylisothiocyanate in soil disinfectants*. Contact Dermatitis 6: 183-186 (1980).

[22] Schubert H. *Contact dermatitis to sodium N-methyldithiocarbamate*. Contact Dermatitis 4:370-371 (1978).

[23] Guidotti TL. *Hydrogen sulfide*. Occup. Med. Vol. 46, (5): 367-371 (1996).

[24] Glass DC. *A review of the health effects of hydrogen sulfide exposure*. Ann Occup. Hyg. Vol. 34(3):323-327 (1990).

[25] US Environmental Protection Agency. Unified Air Toxics Website. Hazard Summary Methyl Isocyanate. http://www.epa.gov/ttn/uatw/hlthef/methylis.html. Accessed May 14, 2001.

[26] Fan AM. California Environmental Protection Agency. Office of Environmental Health Hazard Assessment. Comments to California Department of Pesticide Regulation. Review of the Draft Methyl Isothiocyanate Toxic Air Contaminant Evaluation, August 31, 1999. Department of Pesticide Regulation Staff Responses to Comments, Draft March 2000. http://www.cdpr.ca.gov/docs/empm/pubs/mitc/d435pv.pdf

[27] California Environmental Protection Agency, Office of Environmental Health Hazard Assessment. Chemicals Known to the State to Cause Cancer or Reproductive Toxicity. April 20, 2001. http://www.oehha.org/prop65/prop65_list/42401LstA.pdf

[28] Burgess WA. Philosophy and Management of Engineering Control. In Patty's Industrial Hygiene and Toxicology. Third Edition, Volume III, Part A, Theory and Rationale of Industrial Hygiene Practice: The Work Environment. Harris RL, Cralley L, and Cralley L, Editors. 1994. Page 134.

[29] California Medical Association. Resolution 114-00 "Agricultural Pesticide Drift", March 2000.

[30] California Environmental Protection Agency Department of Pesticide Regulation News Release Release No. 94-42 Contact: Date: December 7, 1994 Veda Federighi (916) 445-3974 Dpr Approves Limited Use Of Soil Fumigant Sacramento. http://www.cdpr.ca.gov/docs/archives/pressrls/1994/94-42.arc Accessed May 14, 2001.

[31] California Department of Pesicide Regulation. Analysis of Pesticide Use in California 1991-1995. December 1998. http://www.cdpr.ca.gov/docs/dprdocs/puranal.htm

[32] California Department of Pesicide Regulation. Pesticide Use and Trends in California 1991-1996. May 1999. http://www.cdpr.ca.gov/docs/pur/pur97rep/pur_anal.pdf

[33] Messenger B, Braun A. Alternatives to Methyl Bromide for the Control of Soil-Borne Diseases and Pests in California. California Department of Pesticide Regulation. September 2000. http://www.cdpr.ca.gov/docs/dprdocs/methbrom/alt-anal/sept2000.pdf

[34] McDuffie HH, Dosman JA, Semchuk KM, Olenchock SA, Senthilselvan A (editors). Introduction. Agricultural Health and Safety. 1995. Boca Raton: CRC Press.

[35] California Technical Information Bulletin Guidelines for All Application Methods for Metam-Sodium in California.

[36] Department of Pesticide Regulation. Permit Conditions for Applications of Metam-Sodium and Potassium N-methydithiocarbamate (Metam-Potassium) Products. Enforcement letter 2000-044, November 15, 2000. Specifically, the Permit Conditions state that “users shall comply with provisions of the Food and Agricultural Code and Title 3 of the California Code of Regulations, the product label, the Technical Information Bulletin (TIB), and permit conditions. Where requirements differ, users shall always follow the more restrictive conditions”.

[37] California Code of Regulations. Division 6. Pesticides and Pest Control Operations, Chapter 1. Pesticide Regulatory Program, Subchapter 1. Definition of Terms, Article 1. Definitions for Division 6, 6000. Definitions.

[38] Personal communication Joe Karl, Deputy Agricultural Commissioner Santa Barbara County.

[39] San Joaquin County Pesticide Episode Investigative Report Incident no. INV96-63.

[40] Wofford PL, Bennett KP, Hernandez J, Lee P. Air Monitoring for Methyl Isothiocyanate During A Sprinkler Application of Metam-Sodium. Cal/EPA, Department of Pesticide Regulation, Environmental Hazards Assessment Program and California Department of Food and Agriculture, Chemistry Laboratory Services. June 1994. These data were obtained under application conditions intended to simulate a “worst case” scenario, i.e., high air temperature, low humidity, warm soil temperatures, and the highest allowable application rate (100 gallons per acre). Data were not available to determine the proportion of metam-sodium applications that are normally conducted under “worst case” application conditions.

[41] CIMIS Project: Hourly weather data for station #88 Cuyama Sensor No: 8 May 14-19, 1999.

[42] Gerstl Z, Mingelgrin U., Yaron B. *Behavior of vapam and methylisothiocyanate in soils*. Soil Sci. Soc. Am J. 41: 545-548 (1977).

[43] Draper WM, Wakeham DE. *Rate constants for metam-sodium cleavage and photodecomposition in water*. J Agric. Food Chem., Vol. 41, No.7: 1129-1133 (1993).

[44] Van Den Berg R, Van Der Linden TMA. Agricultural Pesticides and Groundwater. Zoller U (ed) Environmental Science and Pollution Control Series, 11. Groundwater Contamination and Control. Marcel Dekker, Inc. New York. 293-313 (1994).

[45] The investigation of this incident by the Santa Barbara County Agricultural Commissioner found a number of violations by the grower, and that at least some of the symptoms reported during this episode were the result of exposure to MITC. The Agricultural Commissioner's report concluded that (1) the grower's violations apparently did not contribute to the generation of these symptoms; and (2) current restrictions found in the TIB alone are not sufficient to protect against the occurrence of odor complaints resulting from metam-sodium applications through sprinkler systems. In response to this incident, the Santa Barbara County Agricultural Commissioner increased the residential buffer zone for metam-sodium applications from sprinkler systems from 500 feet to one-mile (Personal communication Joe Karl, Deputy Agricultural Commissioner Santa Barbara County). In Ventura County, the buffer zone for sprinkler applications of metam-sodium has been extended from 500 feet to one-half mile of schools or sites determined to be sensitive by the Agricultural Commissioner (Permit Conditions – Ventura County, item #11).

[46] Seiden AM (Ed.). Taste and Smell Disorders. In Mechanisms of Chemical-Induced Lung Toxicty. Cohn GM, Ganderton D. and Jones TM, Editors. New York 1997 pages 58-67.

[47] Lehrner JP, Gluck J., Laska M. *Odor identification, consistency of label use, olfactory threshold and their relationship to odor memory over the human lifespan*. Chem Senses, 1999 Jun; 24(3):337-46.

[48] Stevens JC, Dadarwala AD. *Variability of olfactory threshold and its role in assessment of aging*. Perception and Psychophysics, 1993 Sept, 54 (3):296-302.

[49] Weinstock RS, Wright HN, Smith DU. *Olfactory dysfunction in diabetes mellitus*. Physiology and Behavior, 1993, Jan, 53 (1):17-21.

[50] Gross-Isseroff R, Ophir D, Bartana A, Voet H, Lancet D. *Evidence for genetic determination in human twins of olfactory thresholds for a standard odorant*. Neuroscience Letters, 1992 Jul 6, 141(1):115-8.

[51] Frye RE, Schwartz BS, Doty RL. *Dose-related effects of cigarette smoking on olfactory function.* JAMA, 1990 Mar 2, 263 (9): 1233-6.

[52] Dalton P, Wysoki CJ. *The nature and duration of adaptation following long-term odor exposure*. Perception and Psychophysics, 58 (5):781-792 (1996).

[53] California Department of Pesticide Regulation. Information sheet on metam-sodium and its breakdown products. November 1999.

[54] Verschueren K. Handbook of Environmental Data on Organic Chemicals. Second Edition. Van Nostrand Reinhold Company, New York. page 858 (1983).

[55] In 1994, the California Environmental Protection Agency Office of Environmental Health Hazard Assessment estimated the one-hour exposure level of MITC at which adverse health effects would not be anticipated in a diverse human population (i.e., the reference exposure level, or REL) to be 0.5 ppb for upper respiratory track irritation, lacrimation and eye irritation. (See Alexeeff et al 1994). Pursuant to evaluating MITC as a toxic air contaminant, in 1999 the California Environmental Protection Agency Department of Pesticide Regulation proposed a 1, 4, 8, or 24-hour acute REL value of 22 ppb. See Department of Pesticide Regulation Staff Responses to Comments, Draft March 2000, page 70. The lowest level at which the odor of MITC is detectable is 200 ppb, nine times greater than the REL of 22 ppb and 400 times greater than the REL of 0.5 ppb.

[56] California Environmental Protection Agency. Office of Environmental Health Hazard Assessment. Evaluation of the Health Risks Associated with the Metam Spill in the Upper Sacramento River. September 21, 1992. Page G-2.

[57] Fenske RA and Simcox NJ. *Agricultural Workers*. In Occupational Health. Recognizing and Preventing Work-Related Disease and Injury. Fourth Edition. Levy BS and Wegman DH, Editors. Lippincott Williams and Wilkins 1999. page 739.

[58] Pruett SB, Myers LP, Keil DE. *Toxicology of metam sodium* . Journal of Toxicology and Environmental Health, Part B. 4:207-222, 2001.